Journal of Research in Chemistry

E-ISSN: 2709-9423
P-ISSN: 2709-9415
JRC 2024; 5(1): 164-168
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www.chemistryjournal.net
Received: 20-04-2024
Accepted: 26-05-2024

Mukesh Baboo
Department of Chemistry, Hindu College, Moradabad, Uttar Pradesh, India

Correspondence
Mukesh Baboo
Department of Chemistry, Hindu College, Moradabad, Uttar Pradesh, India

Assessment of physico-chemical parametres of effluents released from different factories and their irrigational effect on kharif crops

Mukesh Baboo

Abstract
The physico-chemical characteristics of effluents from two different industries *viz*., Oriental Aromatics Ltd. Bareilly and Superior Industry Ltd. Bareilly were assessed and the effect of various concentrations (0%, 25%, 75% and 100%) on mineral uptake in Rice and Maize was determined. The study revealed that the % germination of Rice and Maize was severely affected by these effluents at higher concentrations, whereas a maximum germination was observed at 25% effluent concentration. The uptake of Fe, PO_4, Zn and Cu was found to be in increasing order and was highest at 100% effluent concentration. The above study reveals the feasibility of using industrial effluent for growing vegetables and crops with proper dilution.

Keywords: Effluent, germination, minerals, kharif crops

Introduction
Oriental Aromatics Ltd. and Superior Industry Ltd. C.B. Ganj Bareilly both are the biggest camphor and ethyl alcohol producing industrial units. Effluents of these industries contribute toward environmental pollution, particularly to the aquatic ecosystem. There is a great demand for water for irrigation, while gallons and gallons of effluents are left out into water resources as untreated [1, 2]. The disposal of water is a major problem faced by industries, due to the germination of high volume of effluent and with linked space for land-based treatment and disposal. On the other hands wastewater is also a resource that can be applied for productive use, since wastewater contains nutrients that have the potential for use in agricultural, aquaculture and other activities. Effluent of both industries contain a significant concentration of suspended solids, dissolved solids, high BOD, COD, considerable amounts of chlorides, sulphate, nitrate, Ca and Mg concentration [3]. Diverse both industries effluent disposed of in soil and water cause major pollution problems, while these industries play an important role in the economic developments of India. But the effluents released produce a high degree of organic pollution in both aquatic and terrestrial ecosystem [4]. Because camphor industry effluent is commonly used for irrigation, it is essential to determine how crops respond when exposed to industrial effluent. In this regard efforts have been made to determine the effect of industrial effluents on seed germination of various crops [5]. Distillery factories are also one of the largest and oldest industries present globally and considered to be one of the biggest threats to the environment that produces large amounts of waste that contain organic and inorganic compounds.
The present study deals with the effect of these industrial effluents on certain physico-chemical properties of soil, germination and the mineral uptake by the two kharif crops.

Materials and Methods
The effluents from the both industries at the discharge point were collected at fortnightly intervals and was analysed[6] according to A.P.H.A (1980). Quantitative estimation of heavy metals in effluents were made by using atomic absorption spectrophotometer (AA S300 PerkinElmer).
The seeds of rice and maize were kept in petri dishes lined with three layers of whatman filter paper no.1 moistened with different concentration of effluents *viz*., 25%, 50%, 75%, 100%. A control with distilled water was also set. The emergence of radical and plumule (the radical is the embryonic root of the plant, and grows downwards in the soil.

The plumule is the baby shoot, grows after the radical) was considered as criterion of germination. Each treatment was replicated three times for all crops. Data were analyzed statistically according to Snedecor & Coch-Chran (1967) [7].

Result and Discussion

The physico-chemical characteristics of oriental aromatics and distillery industries effluent are given in Table-1.

Table 1: Physico-chemical characteristics of Industrial effluents

Parameters	Oriental Arom. Factory	Distillery factory
P^H	3.4	4.5
EC (µ mhos/cm)	2760	7400
BOD mg/L	798	6014
COD mg/L	3050	1001
DO mg/L	Nil	7.1
Ca mg/L	119	268
Mg mg/L	79.6	134
Acidity mg/L	10.2	0.6
TSS mg/L	427	987
PO_4 mg/L	3.8	1.6
Cl mg/L	1.52	328
Fe mg/L	ND	ND
Zn mg/L	ND	ND
Cu mg/L	ND	ND
Cr mg/L	ND	ND
Cd mg/L	ND	ND
Pb mg/L	ND	ND

Both of industrial waste indicates its acidic nature. From the above result it is clear that a large amount of TSS is responsible for high BOD & COD of the effluents, which were found to be above permissible limit. i.e. BOD 50 ml/L and COD 250 ml/L (BIS 2010) [8]. The absence of DO indicates high organic matter of the effluent. The presence of heavy metals was not detectable. On the other hands physico-chemical analysis of distillery industry reveals that the sample was also acidic in nature and contains considerable amount of Ca, Mg, TSS, high COD and other basic nutrients above the permissible limits [9, 10] as also shown in fig.-1.

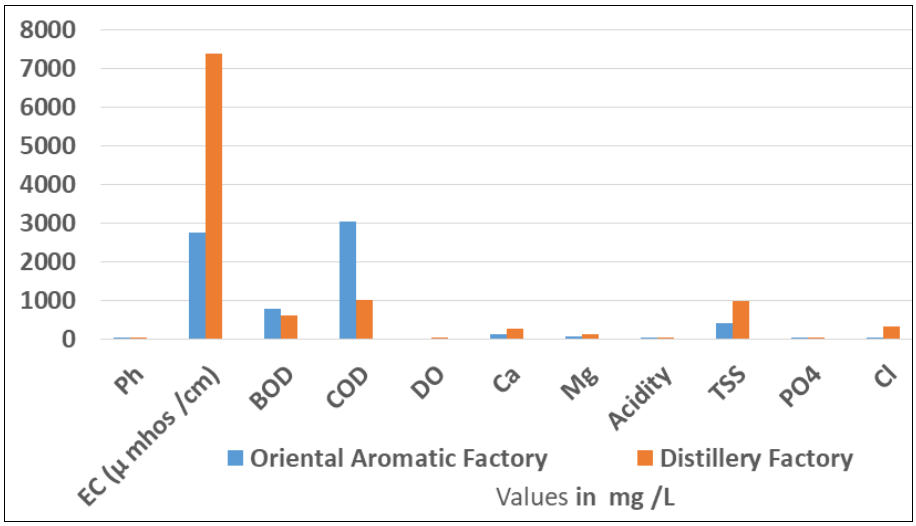

Fig 1: Graph showing physico–chemical characteristics of industrial effluents

Germination test was conducted with seeds of rice and maize with different effluents concentration (25%, 50%, 75%, 100%). The % germination was recorded up to the10th day. The seed germination is 100% in control for maize as well as rice. Percentage germination decreases range from 95.6% to 85.7% in 50%, 75%, 100% effluent concentrations [11] as shown in fig.-2.

Dried plant material was taken and analyzed for Ca, Mg, Na, K, P, Fe, Zn and Cu as shown in table-2 & also in fig-3.

In oriental aromatics factory effluent treated crop Ca, Mg, and K content was higher in 25% concentration than that of control. The Ca content in rice and maize was recorded 5.741-5.571% in 25% concentration and in 5.211-5.571% in control. The Na content was recorded a decrease with increase in effluent concentration ranging from 0.938-1.024% in rice and 1.003-1.04% in maize. The micro nutrients such as Fe ranged from 0.487 -0.489 mg/100g in rice and 0.4818 - 0.4820 mg/100g in maize.

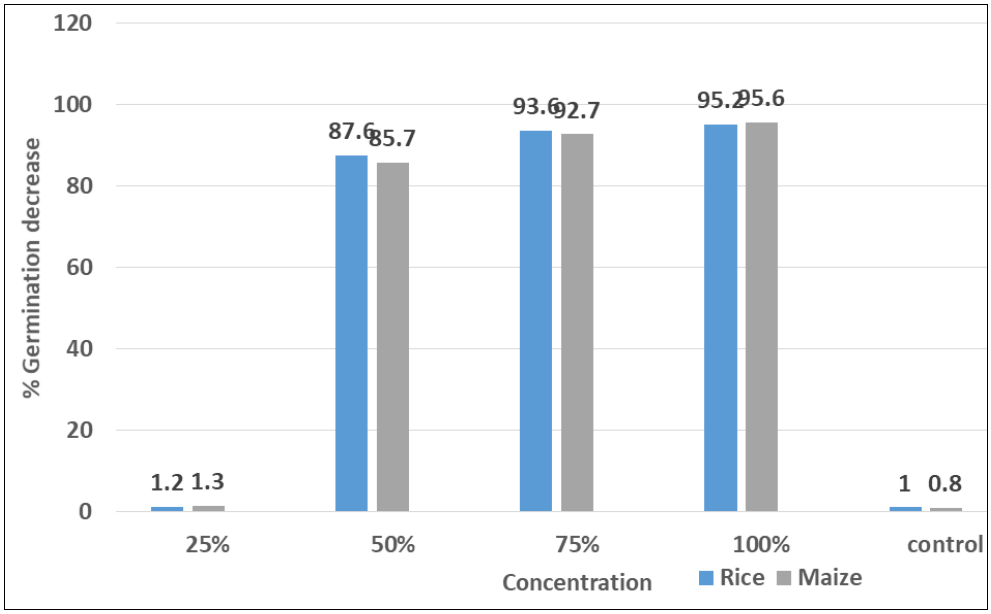

Fig 2: Bar diagram showing decrease in germination

Table 2: Effect of Oriental Aromatics factory effluent on mineral content of two kharif crops at different dilutions

Crops	% Mineral content	Control	25%	50%	75%	100%	F	CD
RICE	Ca	5.211 ± 0.280	5.741 ± 0.456	5.560 ± 0.24	5.11 ± 0.348	4.91± 0.246	1.25**	0.042
	Mg	2.13 ± 0.321	2.23 ± 0.631	2.17± 0.321	2.17 ± 0.567	2.07 ±0.241	1.02 ***	0.56
	K	1.162 ±.182	1.396 ± 0.321	1.248 ± 0.241	1.186 ± 0.321	1.148 ± 0.124	12.67**	0.078
	Na	1.024 ± 0.123	0.991 ± 0.212	0.980 ± 0.341	0.975 ± 0.221	0.938 ± 0.121	170.24***	0.067
	PO_4	0.88±0.125	0.97± 0.144	0.97± 0.221	1.02 ± 0.515	1.05 ± 0.312	210.40***	0.074
	Fe	0.4871 ± 0.34	0.4870± 0.121	0.4876± 0.241	0.4880± 0.514	0.4894± 0.412	2.64***	0.086
	Zn	0.2849 ± 0.121	0.2849± 0.124	0.2855± 0.241	0.2858± 0.561	0.2862±0.441	7.64**	0.073
	Cu	0.3402±0.46	0.3406±0.354	0.3408±0.511	0.3411±0.126	0.3417±0.341	12.40***	0.064
MAIZE	Ca	5.571 ± 0.126	5.751±0.128	5.570±0.221	5.450±0.21	5.393± 821	2.64**	0.103
	Mg	2.26±0.128	2.35±0.126	2.26±0.220	2.31±0.214	2.20±0.125	3.76**	0.024
	K	1.88±0.416	1.303±0.311	1.217±0.234	1.164±0.331	1.124±.043	101.64***	1.67
	Na	1.030±0.513	1.042±0.314	1.020±0.341	1.003±0.312	1.003±0.124	201.34**	0.27
	PO_4	0.91±0.312	0.97±0.126	0.99±0.441	1.02±0.314	1.04±0.561	500.41***	1.33
	Fe	0.4818±0.413	0.4812±0.264	0.4813±0.128	0.4816±0.412	0.4820±0.511	17.64**	0.071
	Zn	0.2908±0.311	0.2909±0.301	0.2912±0.221	0.2917±0.211	0.2917±0.210	13.46***	0.310
	Cu	0.3353±0.511	0.3357±0.216	0.3358±0.310	0.3359±0.231	0.3351±0.341	164.51***	0.078

Significant at P**<0.01, significant at p***<0.001)

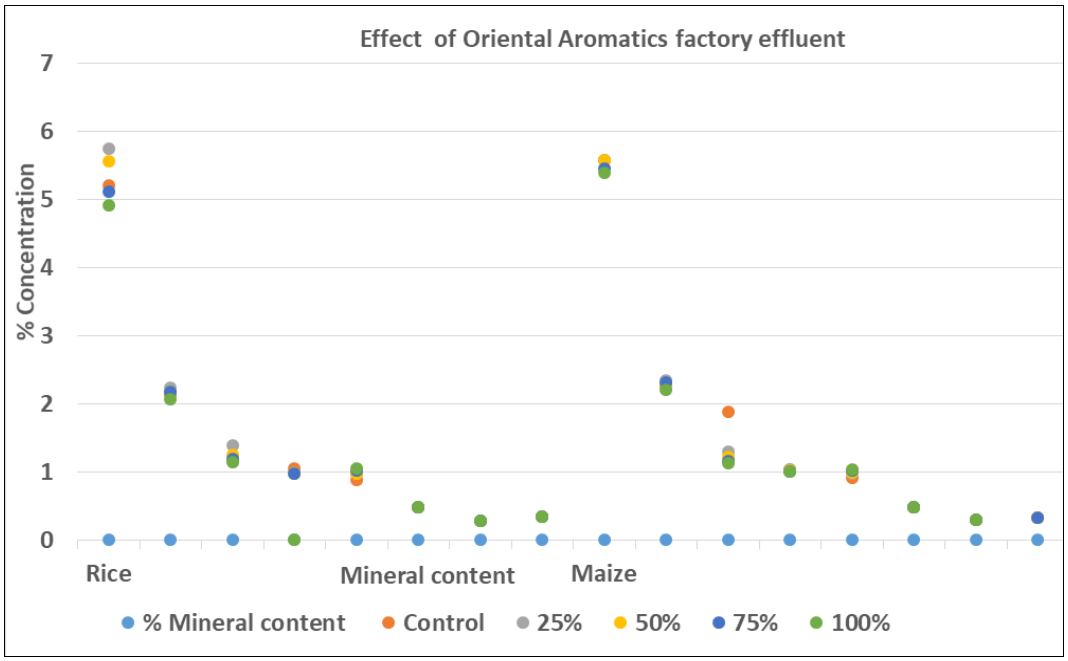

Fig 3: Pattern showing effect of effluent concentration on rice and maize

The increased values except Na may be due to the presence of soluble salts and organic matter which was found to be high in Oriental Aromatics factory effluent, and the decrease in Na uptake by the plant may be due to the lower pH of the effluent [12]. It has been revealed that the plant has observed more K and Mg failed to uptake the required amount of the Na and hence are deficient in Na contents deposit soil having adequate Na.

Table 3: Effect of distillery factory effluent on mineral content of two, kharif crops at different concentration

Crops	% Mineral content	Control	25%	50%	75%	100%	F	CD
RICE	Ca	5.73 ± 0.126	5.61 ± 0.511	5.39 ± 0.412	5.27 ± 0.126	5.27± 0.126	2.31***	0.046
	Mg	2.30 ± 0.121	2.18 ± 0.128	2.14± 0.512	2.13 ± 0.122	2.11 ±0.120	2.46 **	0.076
	K	1.137 ± 0.511	1.28 ± 0.186	1.24 ± 0.122	1.21 ± 0.129	1.21 ± 0.105	103.6***	0.31
	Na	1.13 ± 0.211	1.18 ± 0.121	1.070 ± 0.126	1.06 ± 0.123	1.05 ± 0.127	270.10***	0.031
	PO_4	0.873±0.126	0.874±0.124	0.864 ± 0.186	0.859 ± 0.126	0.859 ± 0.126	160.3***	0.34
	Fe	0.4855 ± 0.216	0.4862± 0.156	0.4864± 0.211	0.4865±0.221	0.4867± 0.127	189.20***	0.101
	Zn	0.2890 ± 0.082	0.2892± 0.155	0.2896± 0.610	0.2897± 0.126	0.2899±0.186	89.6**	0.076
	Cu	0.3560±0.126	0.3565±0.512	0.3569±0.126	0.3572±0.226	0.3573±0.154	12.6***	0.086
MAIZE	Ca	5.53 ± 0.128	5.63±0.216	5.51±0.216	5.46±0.126	5.41± 0.173	14.6**	0.076
	Mg	2.46±0.124	2.36±0.126	2.30±0.212	2.26±0.176	2.24±0.131	13.5**	0.77
	K	1.135±0.126	1.30±0.512	1.29±0.196	1.28±0.126	1.26±.131	102.6***	0.87
	Na	1.050±0.241	1.050±0.216	1.05±0.210	1.04±0.176	1.03±0.311	500.6***	0.076
	PO_4	0.814±0.156	0.837±0.186	0.825±0.127	0.811±0.126	0.807±0.121	13.67**	0.34
	Fe	0.4922±0.261	0.4924±0.211	0.4926±0.121	0.4926±0.161	0.4929±0.106	206.7***	0.079
	Zn	0.2930±0.231	0.2932±0.126	0.2934±0.176	0.2938±0. 121	0.2942±0.136	106.3***	0.087
	Cu	0.3602±0.512	0.3608±0.128	0.3612±0.187	0.3609±0.171	0.3614±0.126	214.7***	0.096

(Significant at P**<0.01, significant at p***<0.001)

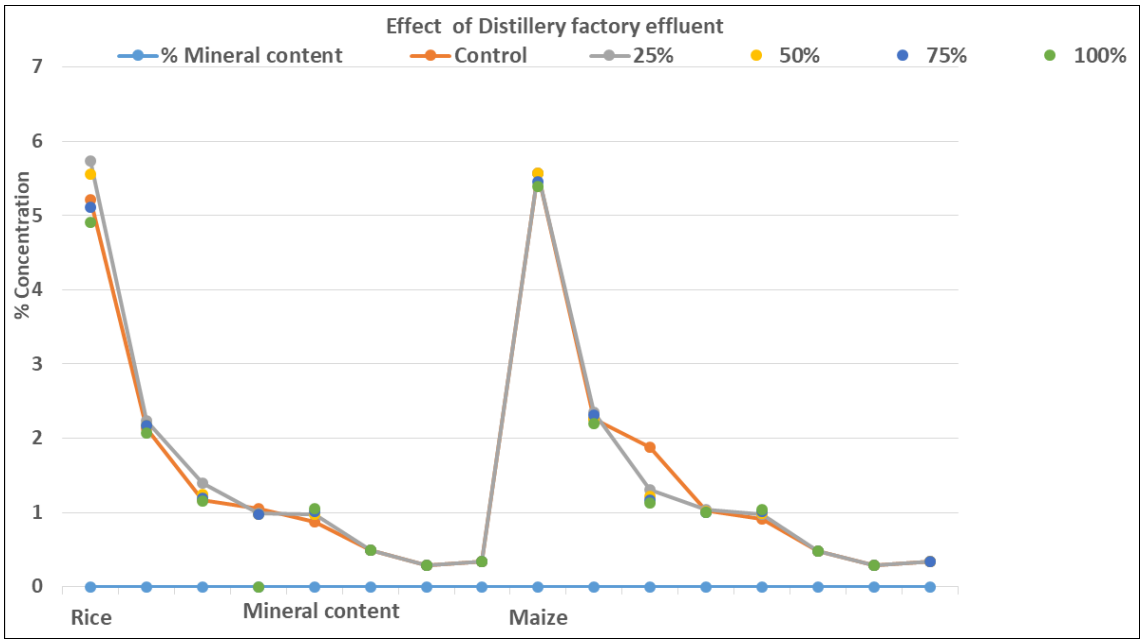

Fig 4: Pattern showing effect of effluent concentration on rice and maize

The uptake of Ca, Mg and K was highest at 25% effluent concentration in all crops. In rice, the Ca uptake was also higher in 50% effluent concentration in comparison to control while when compared to others, crops at 50% effluent concentration the uptake of nutrients was equal to the control value. Mg and K concentration was more than the control value up to 75% concentration was more than the control value up to 75% concentration in most of the crops. Na uptake was found to be less than control value at all the concentration for all the crops. The uptake of Fe, PO_4, Zn and Cu was found in increasing order and was highest at 100% effluent concentration as also shown in fig.-4.

The macro nutrients uptake such as Ca, Mg, K either increased up to 25% effluent concentration in comparison to control. Although the increased value showed marginal difference at higher concentration, these values showed marginal difference at higher concentration, these values were in decreasing order for both the crops. The uptake of Na was high at 25% effluent concentration in comparison to control in rice [13]. Whereas in maize at 25% concentration the value was slightly less than the control. The uptake of PO_4 was found to be in the decreasing order in both the crops with the increase in effluent concentration. The micronutrients Fe, Zn and Cu uptake show marginally increased values in the increasing order of the effluent concentration [14].

Conclusion

On the bases of above findings, it is concluded that the effluent of both factories is severely affected the % germination and mineral content of the crops rice & maize at 100% concentration. Because the effluent is not being treated as per Indian standards. Therefore, effluent is

harmful for both agriculture irrigation and environment. But at 25% & 50% dilution these industrial effluents are also enhancing the growth parameters of both the crops after proper dilution.

Acknowledgement
The authors are thankful to the Dept. of Chemistry, Bareilly College, Bareilly and Principal, Hindu College, Moradabad.

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